

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Errol Todd Ryan et al.	:	Confirmation No.:	2466
Serial No.:	10/791,096	:	Art Unit:	2813
Filed:	3/1/2004	:	Examiner:	Heather Anne Doty
For:	CONTACT LINER IN INTEGRATED CIRCUIT TECHNOLOGY	:		

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Commissioner for Patents
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REPLY BRIEF

Madam:

This Reply Brief is filed under the provisions of 37 CFR §1.193(b)(1). Appellants are cognizant that this Reply Brief is to be directed to such new points of argument that are raised in the Examiner's Answer.

IDENTIFICATION OF, AND REPLY TO NEW POINTS OF ARGUMENT

The following points of argument have been either newly presented in the Examiner's Answer or presented in a different light by the Examiner than earlier in the record.

Issue #1:

Claims 1-8, 11, 12, 15-17, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chang (U.S. Patent 6,858,506, hereinafter "Chang") in view of Lim (U.S. 2004/0115929, hereinafter "Lim").

Regarding the independent claims 1, 6, 11, and 17, Appellants have stated that neither Chang nor Lim teaches, suggests, or mentions:

"forming a silicide...within a thermal budget having a temperature dependent upon the silicide metal" or

"forming contact liners...within the thermal budget for forming the silicide."

It is respectfully submitted that the arguments submitted in the Appeal Brief adequately address the lack of these steps in the cited references and are incorporated by reference thereto.

The Examiner in referring to these claims introduced comments regarding temperatures and thicknesses, and Appellants' arguments addressed the Examiner's comments in the order they were presented.

Regarding claims 1, 2, and 4-5, the Examiner states in the Examiner's Response to Argument with regard to the claimed "thermal budget" that the Chang "temperature range" established obviousness because:

"It has been held that 'in the case where the claimed ranges 'overlap or lie inside ranges disclosed by the prior Art' a prima facie case of obviousness exists." *In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (CCPA 1976); *In re Woodruff*, 919 F.2d 1575, 16 USPQ2d 1934 (Fed. Cir. 1990) (The prior art taught carbon monoxide concentrations of "about 1-5%" while the claim was limited to "more than 5%." The court held that "about 1-5%" allowed for concentrations slightly above 5% thus the ranges overlapped.); *In re Geisler*, 116 F.3d 1465, 1469-71, 43 USPQ2d 1362, 1365-66 (Fed. Cir. 1997) (Claim reciting thickness of a protective layer as falling within a range of "50 to 100 Angstroms" considered prima fade obvious in view of prior art reference teaching that "for suitable protection, the thickness of the protective layer should be not less than about 10 nm [i.e., 100 Angstroms]." The court stated that "by stating that suitable protection' is provided if the protective layer is about' 100 Angstroms thick, [the prior art reference] directly teaches the use of a thickness within [applicant's] claimed range.")." [underlining for clarity]

The Appellants respectfully submit that the invention relates to thermal budgets and discloses the criticality of these thermal budgets as explained in Specification page 9, lines 18-30, which support the claim limitations and include examples regarding ranges:

“Additionally, the contact liners...preferably are formed of...tungsten nitride (WN) when tungsten is used as the metal contact material. Preferably, the contact liners...are selected so that the contact liners...can be deposited using the ALD process within the preferred temperature range of less than or equal to about the thermal budget for the particular silicide being used. In the case of nickel silicides, the thermal budget is about 400⁰C to 450⁰C.

For example, it has been discovered that deposition of WN using the ALD process within a temperature range of about 400⁰C, or less results in the contact liners...having step coverage that is substantially better than the coverage of titanium nitride using a plasma vapor deposition (PVD) or a (MOCVD) process. This is particularly the case as contact holes are manufactured smaller than about 100 microns, and NiSi is used as the silicide material.” [deletions and underlining for clarity]

As well known to those skilled in the art and previously partially explained, the thermal budget defines the total amount of thermal energy transferred to the wafer during a given elevated temperature operation which is proportional to the temperature and duration of the process such that a low thermal budget is possible even at a very high temperature if the time of the process is short. For semiconductor processes, the thermal budget is generally given in units of ⁰C. Exceeding the thermal budget will result in a defective or inoperative integrated circuit. Exceeding a temperature for a short enough time would not affect the integrated circuit.

Assuming *arguendo* that a temperature range is the same as a thermal budget, in *In re Wertheim, supra*, cited by the Examiner, the CAFC explained that:

“ranges which overlap or lie inside ranges disclosed by the prior art may be patentable if the applicant can show criticality in the claimed range by evidence of unexpected results.” (*In re Wertheim*, 541 F.2d 257, 191 USPQ 90 (C.C.P.A. 1976) at 100 (citing *In re Malagari*, 499 F.2d 1297, 182 USPQ 549 (C.C.P.A. 1974); *In re Orfeo*, 440 F.2d 439, 169 USPQ 487 (C.C.P.A. 1971)).

The Appellant-Inventors disclosed a preferred exemplary thermal budget (about 400⁰C to 450⁰C) for a silicide and discovered a particular temperature range (about 400⁰C) for liner deposition. This combination of limitations, as explained in the Specification

quote above, provides better contact liner coverage than the previous benchmark of titanium nitride using PVD or MOCVD processes.

Further, as explained in MPEP 2131.03:

“If the claims are directed to a narrow range, the reference teaches a broad range, and there is evidence of unexpected results within the claimed narrow range, depending on the other facts of the case, it may be reasonable to conclude that the narrow range is not disclosed with “sufficient specificity” to constitute an anticipation of the claims. The unexpected results may also render the claims unobvious.”

Assuming *arguendo* that a temperature range is the same as a thermal budget, the CAFC has most recently held regarding the disclosure of temperature ranges:

“An earlier species can anticipate a later genus, but not necessarily vice versa. Thus, a reference disclosing a temperature range of 100-500°C was too broad to anticipate a range of 330-450°C. The disclosure of 150-350°C did not disclose the range or endpoints of the range 330-450°C. Thus there was no anticipation.” *Atofina v. Great lakes Chem. Corp.*, 78 USPQ2d 1417 (Fed. Cir. 2006)

Based on the above, it is respectfully submitted that a temperature range of 400 to 800°C is too broad to anticipate a thermal budget of 400 to 450°C and a temperature range of between 250°C and 550°C is too broad to anticipate a thermal budget of about 400°C.

Further, regarding claims 1, 2, and 4-5, the Examiner continues:

“Appellants further argue that “the Chang teaching away is even clearer because the claim limitations require both the silicide and the contact liners to be formed within the thermal budget for forming the silicide alone” (Appeal Brief, p. 12, third full paragraph).

However, Chang's not teaching the formation of contact liners does not constitute teaching away from Appellants' invention.”

The Appellants actually argued that the Examiner's citation of Chang's broad temperature range would teach away from a concern with a thermal budget and a limitation that both the silicide and the contact liners be formed within the thermal budget for forming the silicide alone. The argument in the Appeal Brief is incorporated by reference herein.

Regarding claims 1, 2, and 4-5, the Examiner continues:

“Furthermore, Lim teaches forming the contact liner at a temperature range between 250 °C and 550 °C, a range that overlaps with Appellants' disclosed thermal budget for forming nickel silicide.”

It is respectfully submitted that for the claimed thermal budget for nickel silicide of about 400⁰C to 450⁰C, the Applicant-Inventors have declared in the oath that they discovered that the temperature range is about 400⁰C. Thus, the Lim temperature range of between 250°C and 550°C does not anticipate the Applicant-Inventors' disclosed temperature range pursuant to *In re Wertheim, supra*, and *Atofina v. Great lakes Chem. Corp., supra*.

Regarding the pending dependent claims, it is respectfully submitted that the arguments submitted in the Appeal Brief adequately address the lack of these steps or elements in the cited references and are incorporated by reference thereto.

Issue #2:

Claims 9, 11, and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chang (U.S. 6,858,506, hereinafter “Chang”) in view of Lim (U.S. 2004/0115929, hereinafter “Lim”) as applied to claims 6, 11, and 17 above, and further in view of Tseng (U.S. 2005/0035460, hereinafter “Tseng”).

Regarding claims 9, 11, and 17, the Examiner states in the Examiner's Response to Argument with regard to the claimed “ultra-thin silicide” that:

“First, Tseng does not teach away from Appellants' invention by suggesting forming a silicide thicker than 50 Å, since Tseng also suggests forming a silicide with a thickness of 50 Å.”

However, Tseng specifically states at paragraph [0037]:

“The metal silicides ... preferably have a thickness between about 50 Å and 350 Å.” [deletions and underlining for clarity]

Appellants respectfully submit that the Tseng thickness starting from where the Appellants' disclosed thickness ends is a teaching away.

Further, with regard to the criticality of the thickness, the Appellants explained that thicker, rougher silicides were originally thought to be better but Appellants have found that not to be the case stated in Specification page 7, lines 17-33:

“While the present invention may be used with various refractory metal silicides, it has been found that nickel silicide has many desirable characteristics. However, in working with nickel silicide, it has been found to be difficult to form robust nickel. It has been thought that thick silicides around 100 Å thick with rough surfaces would best protect the silicon substrate and provide good adhesion.

However, an ultra-uniform nickel silicide can form extremely robust nickel silicide. By definition, an ultra-uniform silicide means a layer of silicide where there are no variations in thickness greater than about 3% of the overall thickness.

...

Still further, it is preferable that the silicide be deposited under these power levels and deposition rates to an ultra-thin thickness of not more than 50 Å thickness in order to provide an ultra-uniform, ultra-thin silicide.”

It is also respectfully submitted that the Examiner introduced the discussion of the thicknesses with regard to these claims and Appellants merely responded.

Further, regarding claims 9, 11, and 17, the Examiner states in the Examiner’s Response to Argument with regard to the claimed “ultra-thin silicide” that:

“Second, Appellants never claim a silicide thickness of 50 Å. Rather, Appellants claim an “ultra-thin” silicide, a broad term that does not have standard meaning in the art of semiconductor processing. Appellants disclose that “it is *preferable* that the silicide be deposited...to an ultra-thin thickness of not more than 50 Å thickness in order to provide an ultra-uniform, ultra-thin silicide” (instant specification, p. 9, lines 3-5, emphasis added). Appellants do not disclose that for the purposes of patentability, the term “ultra-thin” is defined to be not more than 50 Å.”

It is respectfully submitted that, assuming *arguendo* that the Examiner is correct that the term “ultra-thin” silicide does not have meaning in the art, then the description given in Specification page 9, lines 3-5, and quoted by the Examiner governs the definition of the term because the CAFC has recently held in *Phillips v. AWH Corp.* 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*) that:

“[O]ur cases recognize that the specification may reveal a special definition given to a claim term by the patentee that differs from the meaning

it would otherwise possess. In such cases, the inventor's lexicography governs. See *CCS Fitness, Inc. v. Brunswick Corp.*, 288 F.3d 1359, 1366 (Fed. Cir. 2002). ... the inventor has dictated the correct claim scope, and the inventor's intention, as expressed in the specification, is regarded as dispositive. See *SciMed Life Sys., Inc. v. Advanced Cardiovascular Sys., Inc.* 242 F.3d 1337, 1343-44 (Fed. Cir. 2001)." [deletion and underlining for clarity]

CONCLUSION AND RELIEF REQUESTED

Claims 1-2, 4-7, 9-12, 14-17, 19, and 20 are patentable over the prior art.

Reversal of the Examiner's decision is respectfully requested.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including any extension of time fees, to Deposit Account No. 01-0365 and please credit any excess fees to such deposit account.

Respectfully submitted,



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Claims on Appeal (Please refer to the Appeal Brief)